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**Shuttle Clouds** - A spectacular display of atmospheric effects generated by night launched STS-131 after it burst into high altitude sunlight on April 5, 2010. All images taken by Martin Zloty across Florida in the Tampa Bay region some 100 miles from the launch site.  
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STS-131 launched at 06:21am EDT into a dark sky with the sun deep below the ground horizon. Some three minutes into the flight it broke into high altitude sunlight and from then on produced a varied display of atmospheric effects.

That at top is the last one as, with the main hydrogen and oxygen powered engines still burning, it powered through Earth's mesosphere where the remaining atmosphere is one millionth and less of the density at the ground.

The region is intensely cold because there is little heating by absorption of solar radiation by ozone and it is also very dry. In those conditions the tonnes of water vapour generated by the engines' combustion significantly alter the surrounding atmosphere's composition. The water vapour quickly condenses into ice crystals and it is these that are scattering sunlight.

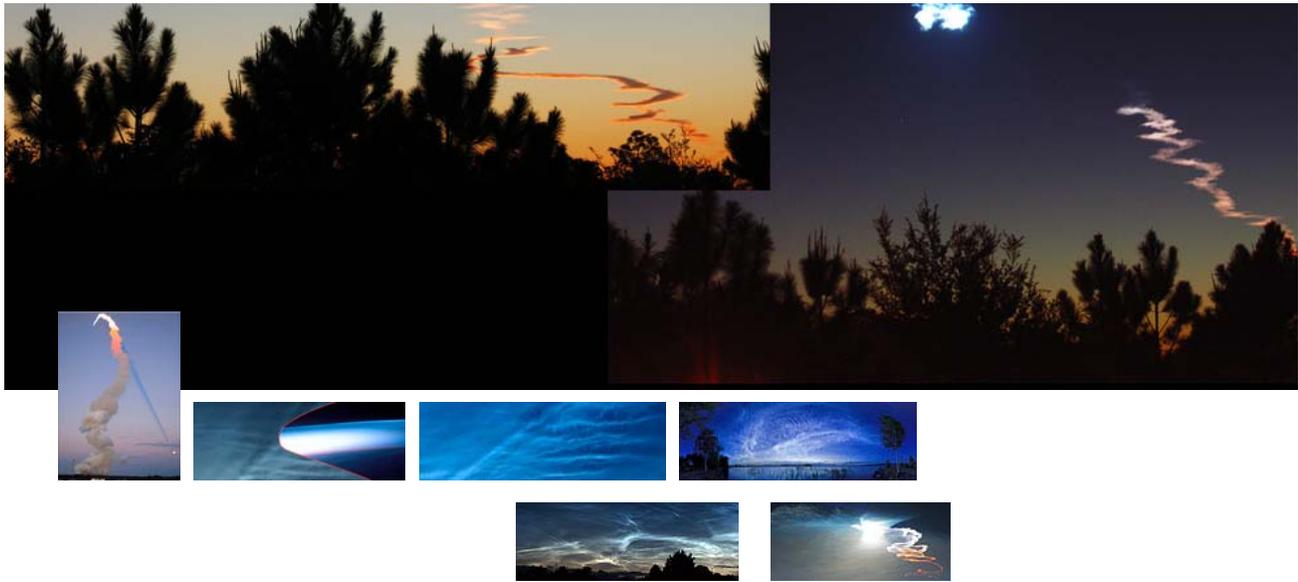
The mesosphere is the region where noctilucent clouds form but this enormous cloud is not quite 'noctilucent' even though it is 'night shining'. It differs in form, NLCs have reticulated and skein-like structure, plus it is faintly iridescent. NLCs are made of minute ice crystals too small to iridesce and are purely the colour of sunlight. This cloud is made of rather larger ice crystals that must have grown quickly close to the vehicle before the water cloud expanded significantly.

At left the lower altitude exhaust trail, contorted and twisted by high altitude winds, is lit by a dawn yet to come on the ground. Sunlight has passed downwards into Earth's dense lower atmosphere and then out and up again to light the trail. During that passage it was intensely reddened. The upper trail shifts to yellow and then white because it was illuminated by a higher sun.

Night launched solid fuelled rockets can give vivid high altitude iridescence as their exhaust smokes scatter and diffract sunlight. This is unlikely to have contributed much here as the boosters were exhausted before the craft reached sunlight.

The transient brightly glowing cloud below needs explanation. Also, why did this launch produce such a spectacle? What were the conditions in the upper atmosphere that allowed such large and copious ice crystals to form?



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